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*Last name*

*First name*

First letter of your last name:

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*perm number*

## EXAM 1 – FORM A

24 April 2009

Chem 1B

Instructor: Ortony

### INSTRUCTIONS:

Use a pencil, fill in the bubbles dark and completely.

Bubble in **Form A** on your Scantron Form

Write your perm number and **bubble in your perm number**, write your name.

Work out the answer to each problem on this exam then bubble in the correct answer on your scantron. **Turn in BOTH the Scantron form and the exam.**

The equation sheet is on the last page, you may remove it from your exam.

The key to the exam will be posted on the course webpage this afternoon.

Exam scores will be posted on “Online Grades”. To access your grade you must create an account first, there is a link on our course webpage (everyone in Chem 1B must create an account – even if you already did so in the past).

1. One mole of an ideal gas is expanded from a volume of 1.50 L to a volume of 10.18 L against a constant external pressure of 1.03 atm. Calculate the work. (1 L•atm = 101.3 J)
- A)  $-8.79 \times 10^2$  J
  - B) -8.94 J
  - C)  $-9.06 \times 10^2$  J
  - D) -0.0883 J
  - E) 9.06 J

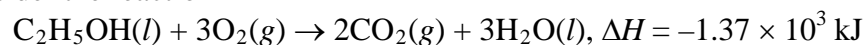
2. Consider the following reaction:



Is the reaction endothermic or exothermic as written?

- A) It is exothermic.
  - B) It is endothermic.
  - C) This can't be determined without more information.
3. Which of the following are state functions?
- A) work, heat
  - B) work, heat, enthalpy, energy
  - C) enthalpy, energy
  - D) work, heat, enthalpy
  - E) heat, enthalpy, energy
4. Suppose you add 45 J of heat to a system, let it do 10. J of expansion work, and then return the system to its initial state by cooling and compression. Which statement is true for this process?
- A)  $\Delta H < \Delta E$
  - B) The work done in compressing the system must exactly equal the work done by the system in the expansion step.
  - C)  $\Delta H = 70. \text{ J}$
  - D) The change in the internal energy for this process is zero.

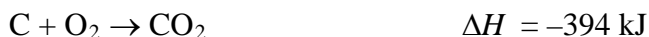
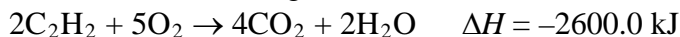
5. Consider the reaction



When a 15.6-g sample of ethyl alcohol (molar mass = 46.1 g/mol) is burned, how much energy is released as heat?

- A) 87.8 kJ
  - B)  $2.14 \times 10^4$  kJ
  - C)  $4.64 \times 10^2$  kJ
  - D)  $4.05 \times 10^3$  kJ
  - E) 4.75 kJ
6. A calorimeter contains 123 g of water at 27.0°C. A block of metal with a mass of 28 g is heated to 95.8°C and then placed in the water in the calorimeter. After sufficient time, the temperature of the water is measured and found to be 28.8°C. Calculate the heat capacity per gram of metal. Assume no heat is lost to the calorimeter or the surroundings.
- A) 2.0 J/g°C
  - B) 0.12 J/g°C
  - C)  $6.8 \times 10^2$  J/g°C
  - D) 0.49 J/g°C
  - E) 0.026 J/g°C

7. At 25°C, the following heats of reaction are known:

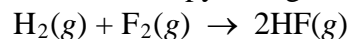


At the same temperature, calculate  $\Delta H$  for the following reaction:



- A) 226 kJ
- B) -226 kJ
- C) 2422 kJ
- D) -2422 kJ
- E) none of these

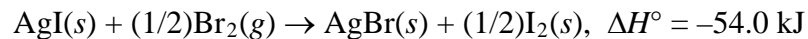
8. The standard enthalpy change for the following reaction is  $-542 \text{ kJ}$ :



Calculate the standard enthalpy of formation of hydrogen fluoride.

- A)  $-542 \text{ kJ/mol}$
- B)  $542 \text{ kJ/mol}$
- C)  $-271 \text{ kJ/mol}$
- D)  $-1084 \text{ kJ/mol}$
- E) none of these

9. For the reaction



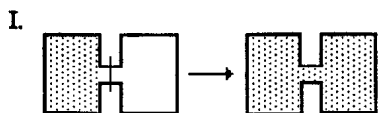
$$\Delta H^\circ_f \text{ for AgBr}(\text{s}) = -100.4 \text{ kJ/mol}$$

$$\Delta H^\circ_f \text{ for Br}_2(\text{g}) = +30.9 \text{ kJ/mol}$$

The value of  $\Delta H^\circ_f$  for  $\text{AgI}(\text{s})$  is

- A)  $-123.5 \text{ kJ/mol}$
- B)  $+77.3 \text{ kJ/mol}$
- C)  $+61.8 \text{ kJ/mol}$
- D)  $-77.3 \text{ kJ/mol}$
- E)  $-61.8 \text{ kJ/mol}$

10. Consider the process  $A(l) \rightleftharpoons A(s)$ . Which direction favors positional randomness?
- A) to the right  
 B) to the left  
 C) neither  
 D) It depends on the temperature.
11. Consider the process  $A(l) \rightleftharpoons A(s)$ . An increase in temperature favors which direction?
- A) to the right  
 B) to the left  
 C) neither  
 D) More information is needed.
12. Which of the following result(s) in an increase in the entropy of the system?



- I. (See diagram.)
- II.  $\text{Br}_2(g) \rightarrow \text{Br}_2(l)$
- III.  $\text{NaBr}(s) \rightarrow \text{Na}^+(aq) + \text{Br}^-(aq)$
- IV.  $\text{O}_2(298 \text{ K}) \rightarrow \text{O}_2(373 \text{ K})$
- V.  $\text{NH}_3(1 \text{ atm}, 298 \text{ K}) \rightarrow \text{NH}_3(3 \text{ atm}, 298 \text{ K})$
- A) I  
 B) II, V  
 C) I, III, IV  
 D) I, II, III, IV  
 E) I, II, III, V

Use the following to answer questions 13-14:

One mole of an ideal gas expands isothermally and reversibly at  $0^{\circ}\text{C}$ . The pressure on 1 mol of an ideal monatomic gas changes from 100.0 atm to 1.00 atm.

13. Calculate  $w$ .
- A) 225 kJ
  - B) -225 kJ
  - C) 10.5 kJ
  - D) -10.5 kJ
  - E) 0
14. Calculate  $q$ .
- A) 225 kJ
  - B) -225 kJ
  - C) 10.5 kJ
  - D) -10.5 kJ
  - E) 0
15. Which of the following is true?
- A) As long as the disorder of the surroundings is increasing, a process will be spontaneous.
  - B) For any process,  $\Delta S_{\text{surr}}$  and  $\Delta S_{\text{sys}}$  have opposite signs.
  - C) If  $\Delta S_{\text{surr}} = -\Delta S_{\text{sys}}$ , the process is at equilibrium.
  - D)  $\Delta H^{\circ}$  is zero for a chemical reaction at constant temperature.
  - E) none of these
16. For which process is  $\Delta S$  negative?
- A) evaporation of 1 mol of  $\text{CCl}_4(l)$
  - B) mixing 5 mL of ethanol with 25 mL of water
  - C) compressing 1 mol of Ne at constant temperature from 1.5 atm to 0.5 atm
  - D) raising the temperature of 100 g of Cu from 275 K to 295 K
  - E) grinding a large crystal of KCl to powder
17. 5.50 mol of a monatomic ideal gas is cooled from  $246^{\circ}\text{C}$  to  $27^{\circ}\text{C}$  at constant volume. Calculate  $\Delta S$ .
- A)  $-62.7 \text{ J/K}$
  - B)  $-16.3 \text{ J/K}$
  - C)  $-27.2 \text{ J/K}$
  - D)  $-37.6 \text{ J/K}$
  - E)  $-1.52 \times 10^2 \text{ J/K}$

18. Calculate  $\Delta S$  for cooling 1.5 mol of an ideal monatomic gas from  $81^\circ\text{C}$  to  $36^\circ\text{C}$  at constant pressure.
- A)  $-1.70 \text{ J/K}$
  - B)  $-25.3 \text{ J/K}$
  - C)  $-4.24 \text{ J/K}$
  - D)  $-2.54 \text{ J/K}$
  - E)  $-2.83 \text{ J/K}$

19. Consider the freezing of liquid water at  $-10^\circ\text{C}$ . For this process what are the signs for  $\Delta H$ ,  $\Delta S$ , and  $\Delta G$ , respectively?
- A) +   -   0
  - B) -   +   0
  - C) -   +   -
  - D) +   -   -
  - E) -   -   -

20. Consider the reaction
- $$2\text{N}_2\text{O}_5(g) \rightleftharpoons 4\text{NO}_2(g) + \text{O}_2(g)$$
- at  $25^\circ\text{C}$ , for which the following data are relevant:

	$\Delta H^\circ_f$ (kJ/mol)	$S^\circ$ (J/K•mol)
$\text{N}_2\text{O}_5$	11.29	355.3
$\text{NO}_2$	33.15	239.9
$\text{O}_2$	?	204.8

Calculate  $\Delta S^\circ$  for the reaction.

- A)  $89.5 \text{ J/K}$
- B)  $-249.2 \text{ J/K}$
- C)  $453.8 \text{ J/K}$
- D)  $249.2 \text{ J/K}$
- E)  $-115.6 \text{ J/K}$

21. The reaction



has a positive value of  $\Delta G^\circ$ . Which of the following statements **must** be true?

- A) The reaction is slow.
- B) The reaction will not occur. That is, when  $\text{H}_2\text{O}(g)$  is introduced into a flask, no  $\text{O}_2$  or  $\text{H}_2$  will form even over a long period of time.
- C) The reaction is exothermic.
- D) The equilibrium lies far to the right.
- E) None of these is true.

22. At 699 K,  $\Delta G^\circ = -23.25$  kJ for the reaction  $\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)$ . Calculate  $\Delta G$  for this reaction if the reagents are both supplied at 10.0 atm pressure and the product is at 1.00 atm pressure.

- A) -3.5 kJ
- B) -36.6 kJ
- C) +36.6 kJ
- D) -50.0 kJ
- E) +50.0 kJ

Form A:

1. C
2. A
3. C
4. D
5. C
6. D
7. A
8. C
9. E
10. B
11. B
12. C
13. D
14. C
15. C
16. C
17. D
18. C
19. E
20. C
21. E
22. D